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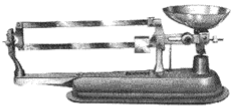
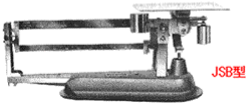
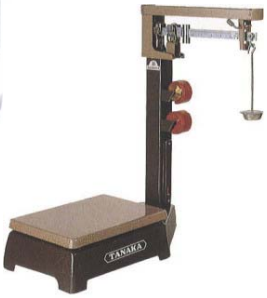
Various NAWIs -1







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Various NAWIs -2

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Requirement for OIML R76

1. Metrological requirements
2. Technical requirements
3. Administrative requirements

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Metrological requirements

Test under normal ambient conditions:

1. Zero-setting range and accuracy
2. Weighing performance test
3. Tare
4. Eccentricity
5. Discrimination
6. Sensitivity
7. Repeatability
8. Creep
9. Zero return
10. Stability of equilibrium

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Metrological requirements

Tests under influence factors:

1. Tilting
2. Warm-up test
3. Weighing performance at static temperature
4. Damp heat,steady state
5. Voltage variations

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Temperature and humidity chamber

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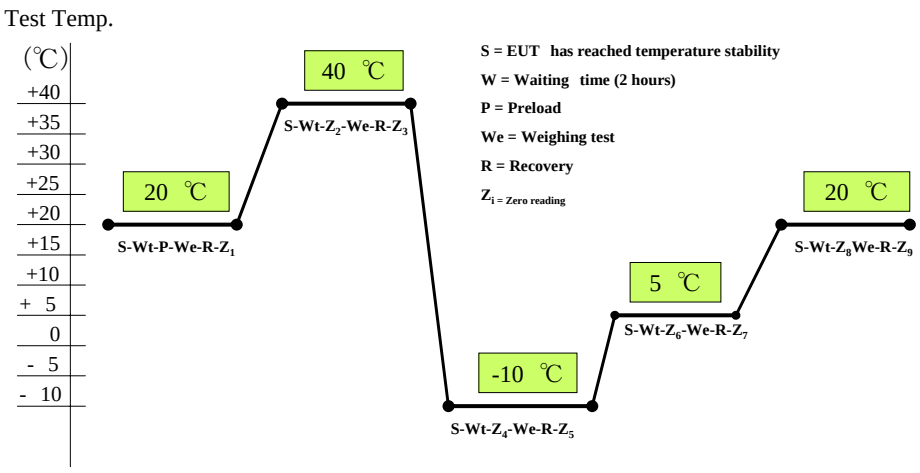
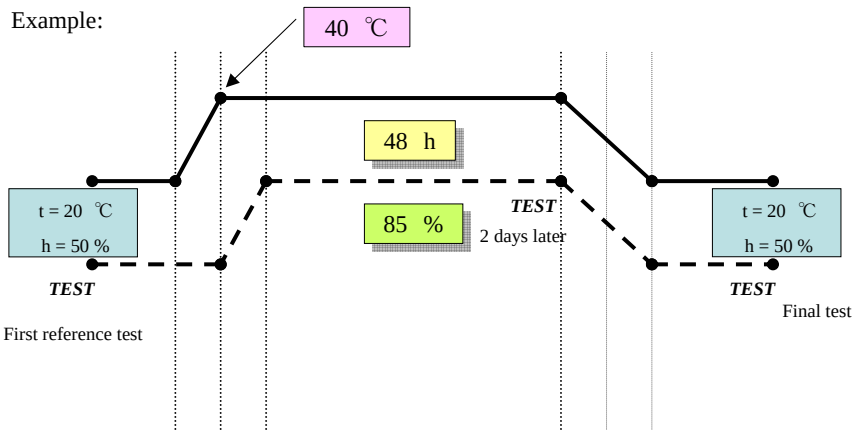
Metrological requirements
(Static temperature test)



Metrological requirements
(Test sequence for damp heat, steady state)



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Variation of voltage

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Metrological requirements

Tests under disturbances (EMI/EMC):

1. Short power reductions
2. Electrical bursts
3. Electrostatic discharge
4. Immunity to radiated electromagnetic fields

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Electrical disturbances

Short time power reductions

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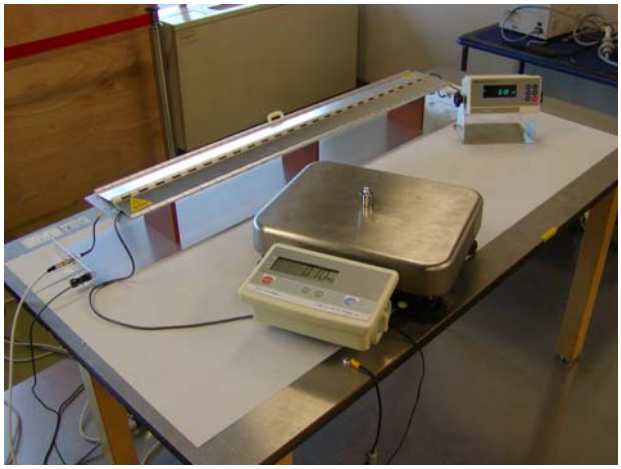
Electrical bursts

I/O circuits and communication line



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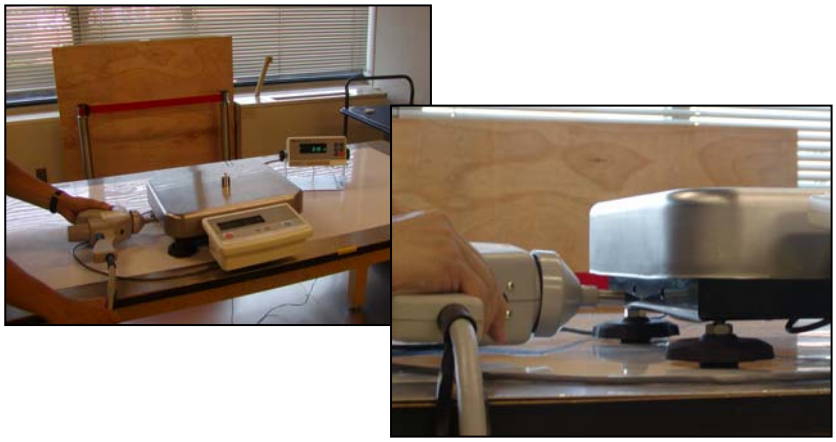
Electrostatic discharges

Direct Application



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Electrostatic discharges

Direct Application (air discharges)

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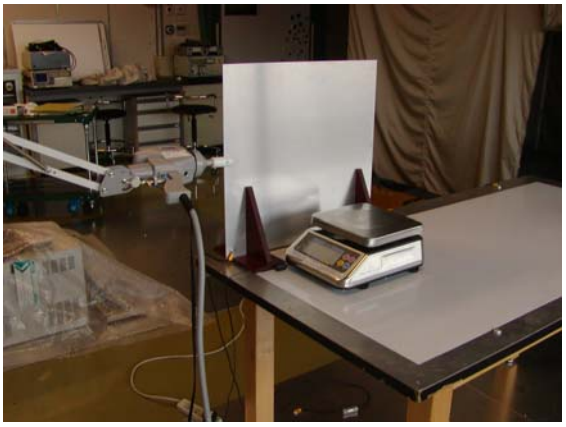
Electrostatic discharges

Indirect Application (Vertical)



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Electrostatic discharges

Indirect Application (Horizontal)

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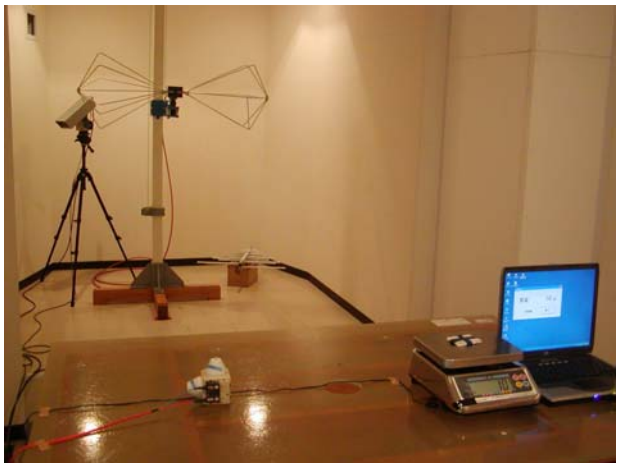
Immunity to radiated electromagnetic fields



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Metrological requirements

Tests with regard to long-term stability:

1. Span stability test
2. Endurance test

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Endurance

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Accuracy classes for NAWI's

1. Class 1 Special accuracy
   ultramicro-,micro-,semimicro,macro-
2. Class 2 High accuracy
   precision balances,
3. Class 3 Medium accuracy
   NAWI's for trade use
4. Class 4 Ordinary accuracy
   NAWI's for lower accuracy

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Accuracy classes for NAWI's

Accuracy class	Verification scale interval e	Number n=Max/e n ≧	Number n=Max/e n ≦	Minimum Capacity Min ≧
(I)	0.001g ≦ e	50,000		100 e
(II)	0.001g ≦ e ≦ 0.05 g 0.1 g ≦ e	100 500	100,000 100,000	20 e 50 e
(III)	0.001g ≦ e ≦ 0.05 g 0.5 g≦ e	100 500	10,000 10,000	20 e 20 e
(IIII)	0.5g ≦ e	100	1,000	100 e

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Classification of instruments
(Table 3)

Maximum permissible errors on initial verification	for load m expressd in verificatuion scale interval e			
	Class 1 (I)	Class 2 (II)	Class 3 (III)	Class 4 (IIII)
± 0.5 e	0 ≦ m ≦ 50,000	0 ≦ m ≦ 5,000	0 ≦ m ≦ 500	0 ≦ m ≦ 50
± 1.0 e	50,000 < m ≦ 200,000	5,000 < m ≦ 20,000	500 < m ≦ 20,000	50 < m ≦ 200
± 1.5 e	200,000 < m	20,000 < m ≦ 100,000	2,000 < m ≦ 10,000	200 < m ≦ 1,000

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Multi-interval

- instruments have <u>one</u> weighing range,
- divided into partial weighing ranges by the manufacture
- each partial weighing range with different e determined by the manufacture
- Which partial weighing range is determined automatically both on increasing and decreasing load

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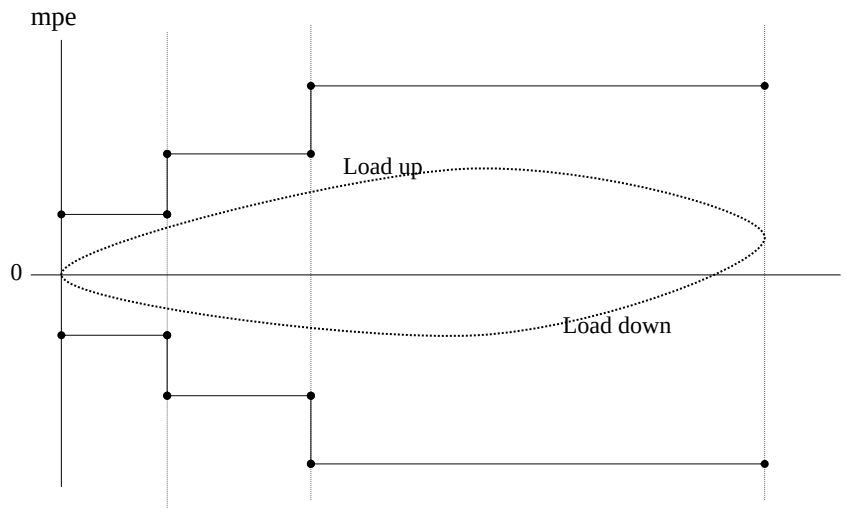
Multi-interval



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Multi-interval:requirements

- e_i and n_i shall comply with table 3
- the range shall comply with table 4

with the exception of the highest partial weighing range

Maximum capacity of partial weighing ranges
(Table 4)

Class	I	II	III	IIII
Max_i/e_{i+1}	> 50 000	> 5 000	> 500	> 50

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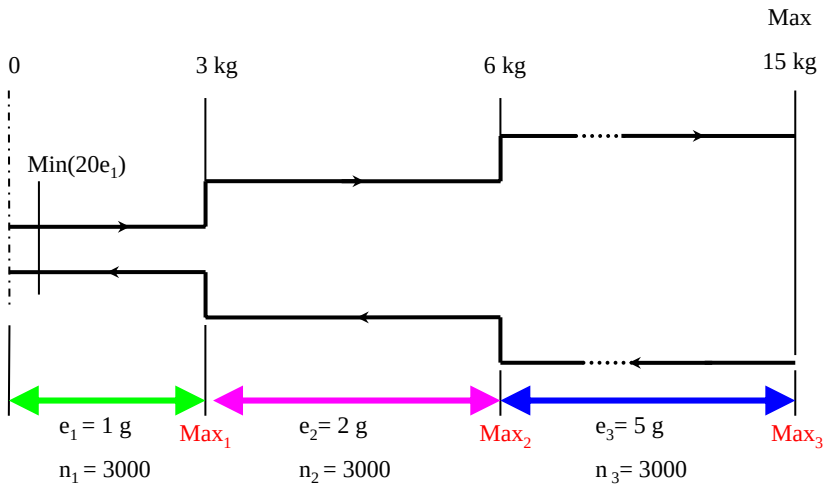
Multi-interval



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Multi-interval

- If load > 3000g,instrument automatically change to e_2=2g
- If load is removed to under 3000g, instrument automatically change to e_1=1g
- If load > 6000g, instrument automatically change to e_3=5g
- If load is removed to under 6000g, instrument automatically change to e_3=5g

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Multi-interval;example

- e_1=1g and Max_1 = 3000g,than n_1 =3000
- e_2=2g and Max_2 = 6000g,than n_2 = 3000
- e_3=5g and Max_3 = 15000g,than n_3 =3000

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Multi-interval:consequences

- Requirement apply to the net load for each possible value of tare
- For influence factors e is to be taken according to the load applied,

  at or near zero load e = e_1

Multi-range

- Instrument has two or more weighing ranges,

- with different Max
- different e
- each range extending from zero to Max;

Multi-range:requirements

- e_i and n_i shall comply with table 3
- Requirement apply to next load for each possible value of tare
- For influence factors e is to be taken according to the load applied,
  - at or near zero load $e = e_i$

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Multi-range

- The weighing range which is operation should be clearly indicated
- Manual selection is allowed from a smaller to a greater weighing range
- From a greater to a smaller weighing range when there is no load on the load receptor
  - and indication is zero or negative net value
  - tare operations is cancelled
  - and zero is set within 0.25 e_1

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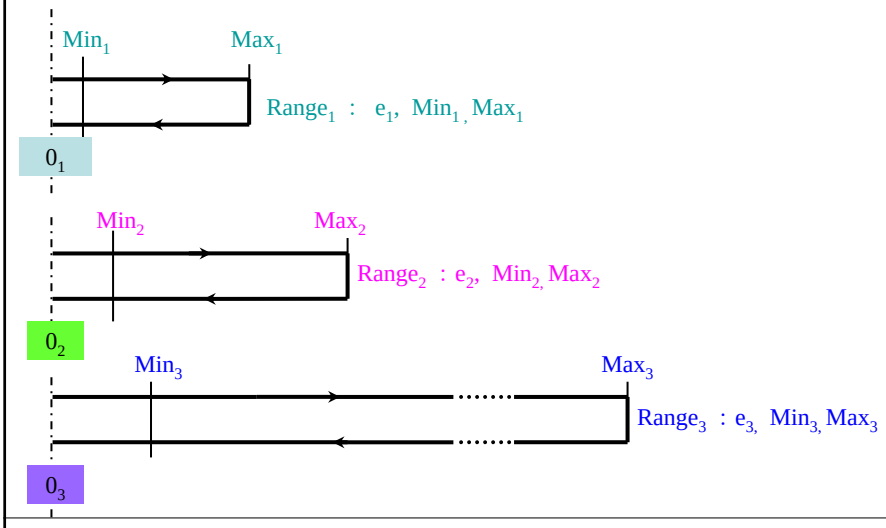
Multiple-range



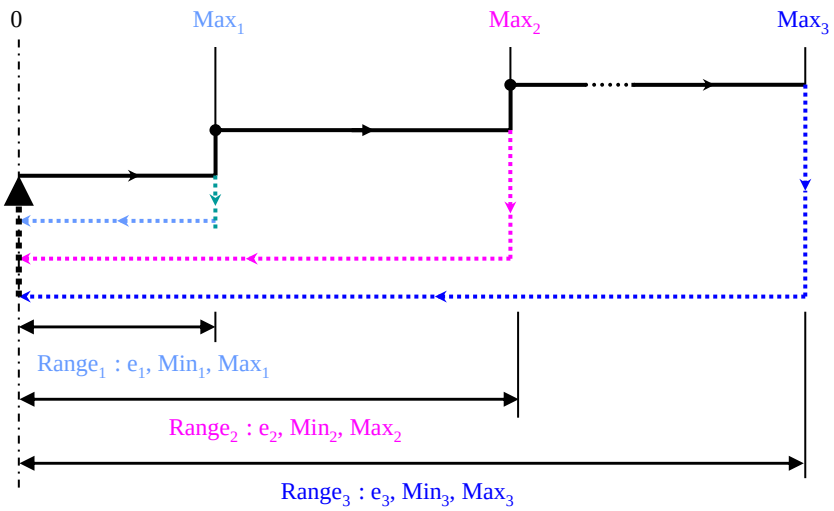
Multiple-range

- Automatic selection is allowed when load exceeds Max gross weight of range being in operation

  From a greater to a smaller weighing range when there is no load on the load receptor

  - and indication is zero or negative net value
  - tare operations is cancelled
  - and zero is set within 0.25 e_1

Multiple-range auto change



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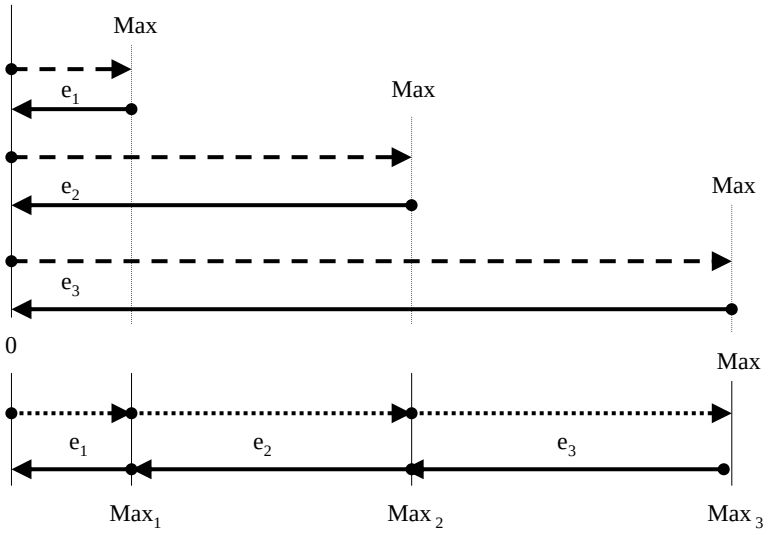
Multiple-range /Multi-interval



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Zero-setting device

Zero-setting device is a device for setting the indication to zero when there is no load on the load receptor.

- initial zero-setting device
- automatic zero-setting device
- semi- automatic zero-setting device
- non-automatic zero-setting device

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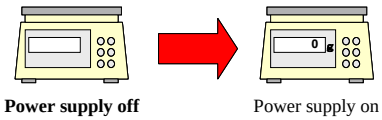
Zero-setting device

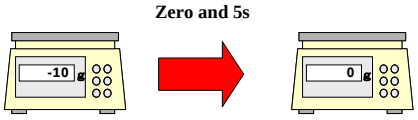
(A) Initial zero-setting device



Power supply off Power supply on

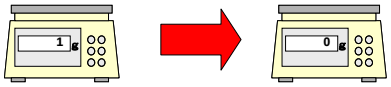
(B) Automatic zero-setting device

Zero and 5s



(C) Semi-automatic zero-setting device

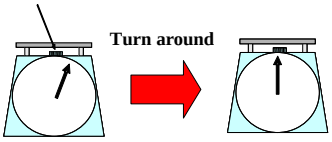
Zero key



(D) Non automatic zero-setting device

Zero adjustor

Turn around



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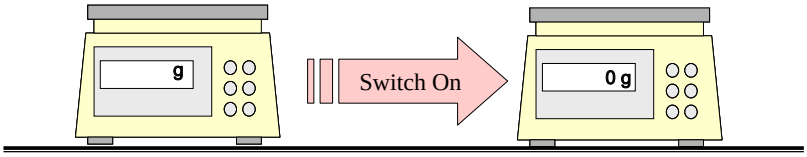
Initial zero-setting device

- Initial zero-setting device is a device for setting to zero automatically at the time the instrument is switched of Power Supply on and before it is ready to use



NAWI condition *Power supply off* *Power supply on*

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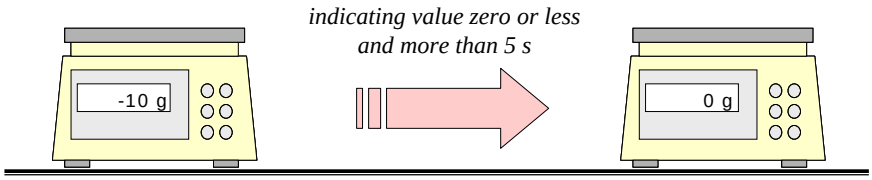
Automatic zero setting device

- Automatic zero-setting device is a device for setting to zero automatically, only allowed when zero-point is negative, not allowed to operate when indication is positive



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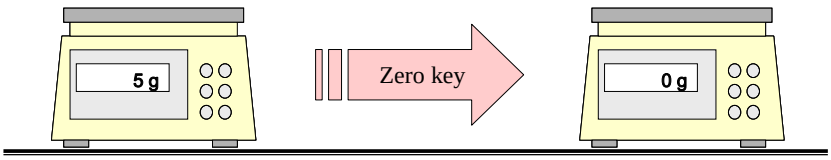
Semi- automatic zero setting device

- Semi- automatic zero-setting device is a device for setting the indication to zero automatically following a manual command



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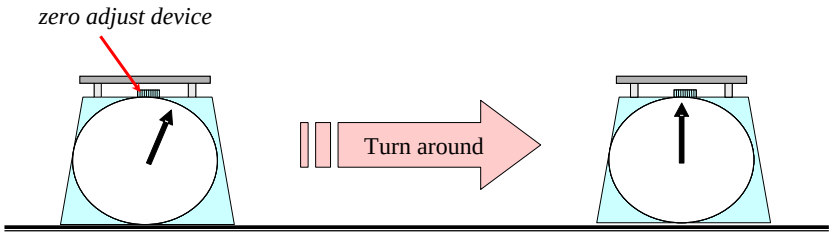
Non automatic zero setting device

- Non-automatic zero-setting device is a device for setting the indication to zero by operator



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Zero-setting requirements

- The effect does not alter Max
- The accuracy is 0.25 e or 0.5 d on a auxiliary indicating device
- The range is 4 % of Max for zero-setting
- The range is 20 % of Max for initial zero-setting device unless instrument complies with metrological requirements ,than more than 20% is allowed
- The equilibrium is stable

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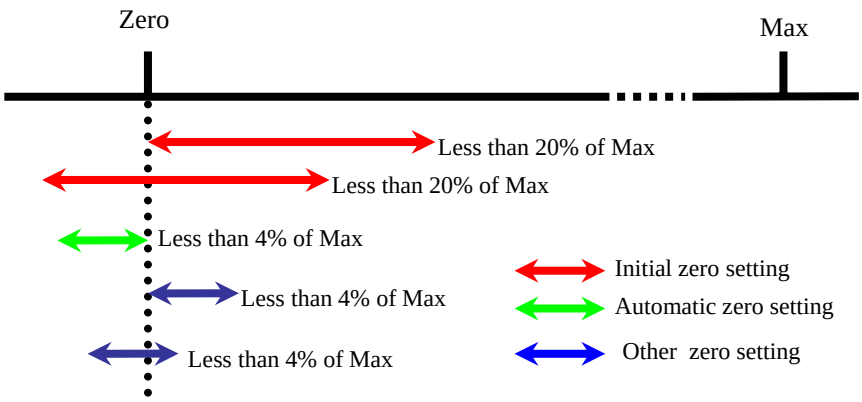
Zero setting device
(Maximum effect)



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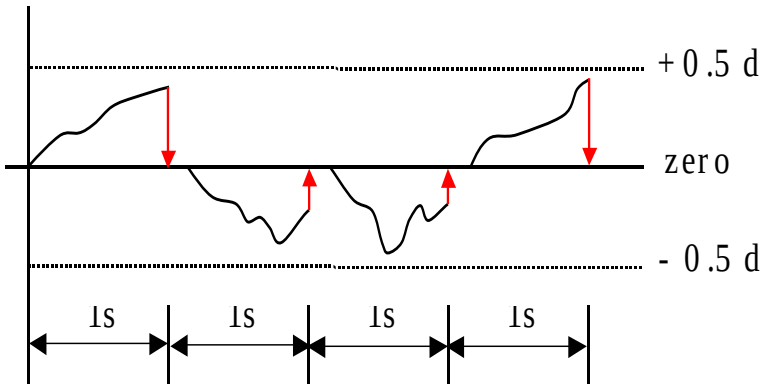
Zero-tracking device

- zero-tracking device is a device for maintaining the zero indication within certain limits automatically

Zero-tracking requirements

- the indication is at zero or negative net value
- the equilibrium is stable
- the corrections are not more than 0.5 d per one second
- the range is not than 4% of Max

Zero-tracking



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Tare device

- Device for setting the indication to zero when a load is on the load receptor
- Two types:
  - setting to zero without altering the weighing range for net loads(additive tare device)
  - Setting to zero reducing the weighing range for net loads (sub-tractive tare device)

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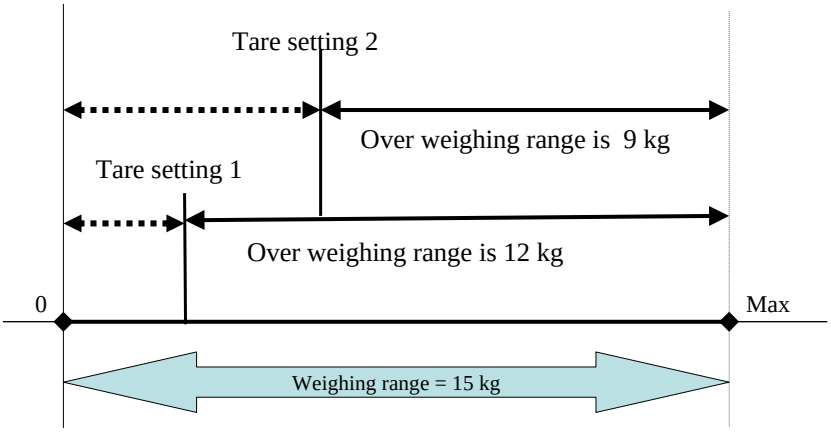
Tare device
(Sub-tractives tare)



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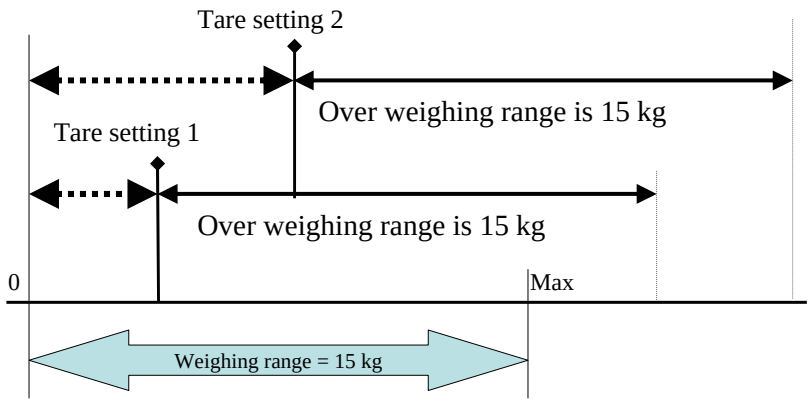
Tare device
(Additive tare)



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Tare device
(Functional requirements)

- If more than one tare device is in use,tare value should be clearly designated
- If tare value is printed,they should be designated with T and the net value should be designated with N

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Tare device
(Metrological requirements)

- accuracy 0.25 e or 0.5 d for auxiliary indicating device
- operating range as indicated
- not bellow or at zero point
- the equilibrium is stable

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Test Items

1. Values of maximum permissible error on initial verification
2. Maximum permissible error for net values
3. Discrimination
4. Repeatability
5. Tare weighing device
6. Eccentricity
7. Accuracy of zero setting device
8. Accuracy of tare device

※ ***Visual inspection***

1）metrological characteristic

2) prescribed inscription and position for verification and control marks

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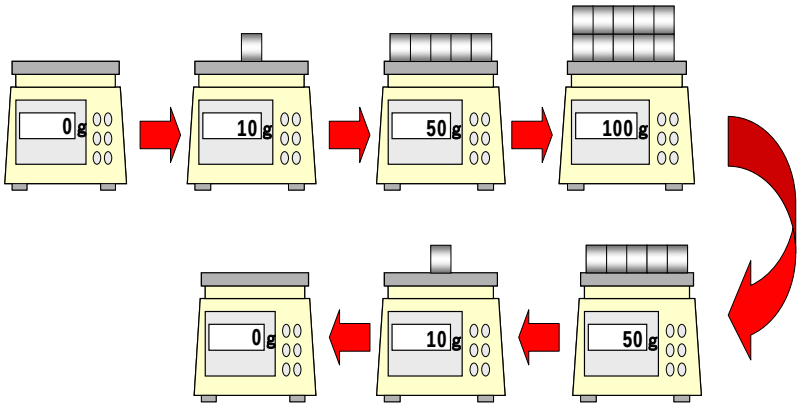
Standard Procedure for WPT



(WPT : Weighing Performance Test)

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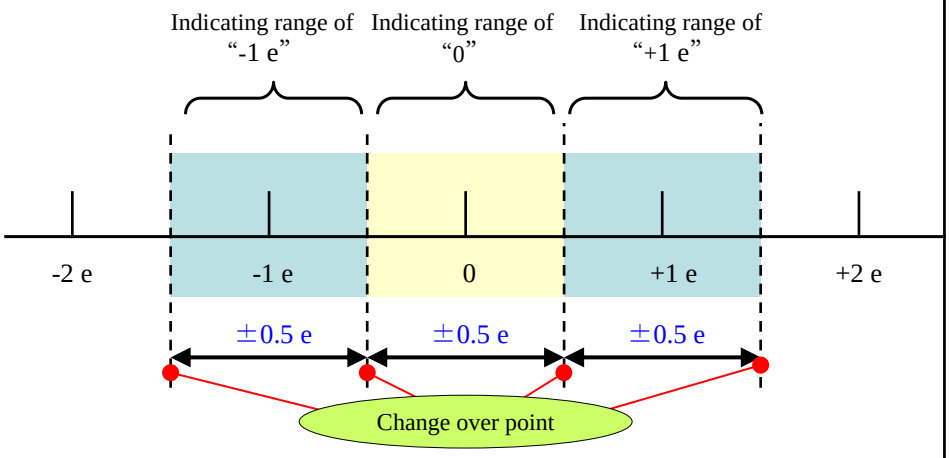
Weighing Performance Test
(Rounding of indication)



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Error Formula

$$E = I + 1/2e - \Delta L - L = P - L$$

I = Indication
e = Verification scale interval
L = Load
ΔL = Additional load to next change over point
P = I + 1/2e - ΔL = indication prior to rounding
E = I - L or P - L = error
$E_c = E - E_0$ with E_0
= error calculated at or near zero (*)

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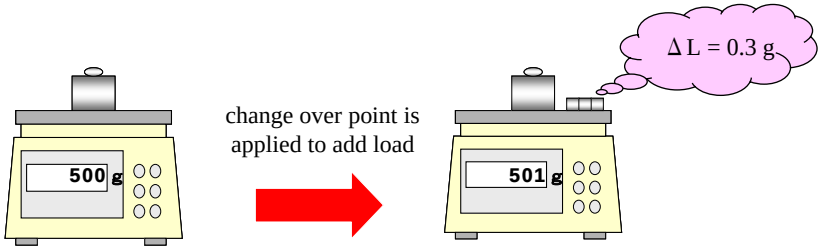
Weighing Performance Test

Example: e = 1 g

Load	Indication	Add.load(Δ L)	Error
500 g	500 g	0.3 g	?



E = 500 + 0.5 -0.3 – 500 = + 0.2 g

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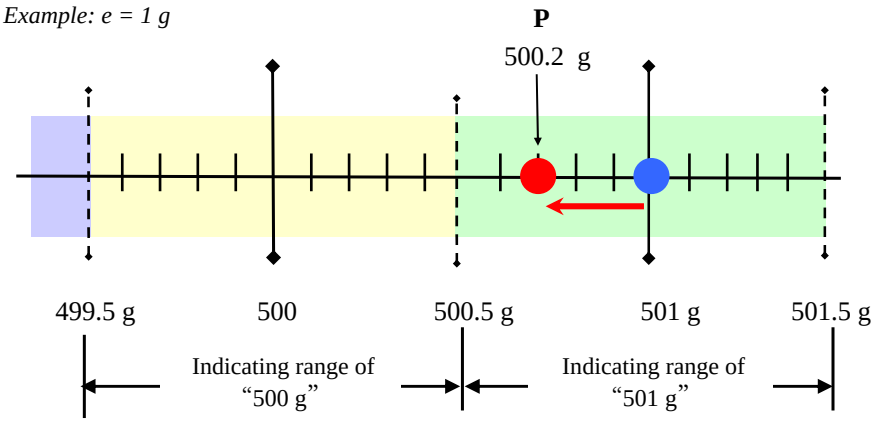
Weighing Performance Test

Example: e = 1 g



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Error Formula

Load(L)	Indication (I)		Add.Load (⊿L)		Error (E)		Corrected erorr (Ec)		mpe
	↓	↑	↓	↑	↓	↑	↓	↑	
(*)									

$$E = I + 1/2e - \Delta L - L$$

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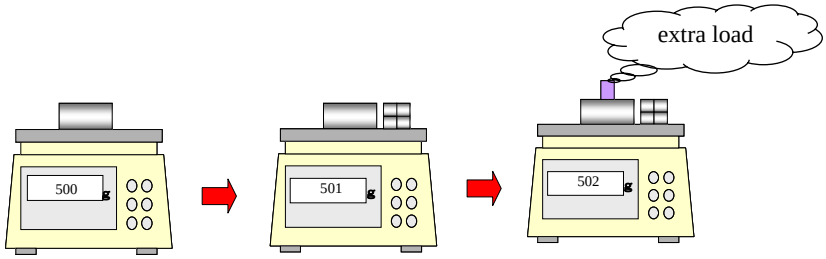
Discrimination Test

Unit : g

Load	Indication	Add.load (ΔL)	Indication (I_1)	Extra load	Indication (I_2)	I_2-I_1
500	500	0.4	501	1.4	502	1



applied to Test load

change over point is applied to add load

applied to 1.4 e extra load

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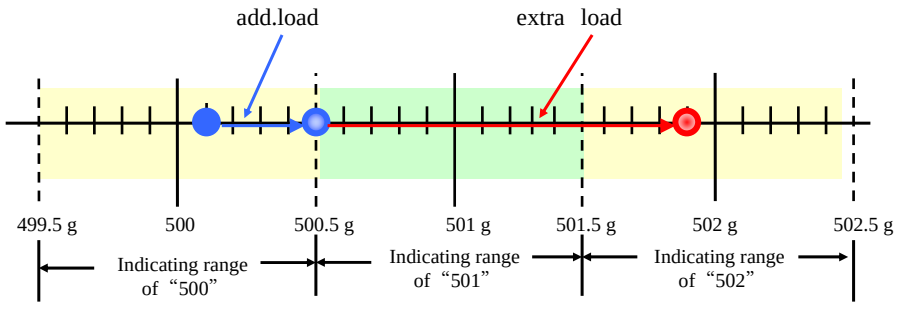
Discrimination Test



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Discrimination Test

Digital indication

Load (L)	Indication (I)	Removd load (⊿L)	Add 1/10 d	Extra load = 1.4 d	Indication I_2	$I_2 - I_1$

☐ Passed ☐ Failed

Analogue indication

Load (L)	Indication (I_1)	Extra load = | mpe |	Indication (I_2)	$I_2 - I_1$

☐ Passed ☐ Failed

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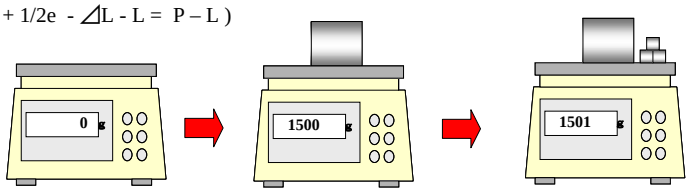
Repeatability Test

Example: Class

No	Load	Indication	Add.load(Δ L)	P
1	1500	1500	0.3	1500.2
2				
3				

(E = I + 1/2e - ⊿L - L = P – L)



zero setting and check

applied to Test load

change over point is applied to add load

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Repeatability Test

Verification scale interval e: _____

Test load : _____

P = I + 1/2 e-⊿L

No.	Indication (I)	Add.load (⊿L)	P	No.	Indication (I)	Add.load (⊿L)	P
1				6			
2				7			
3				8			
4				9			
5				10			

Max -Min ☐ mpe ☐

☐ PASSED

☐ FAILED

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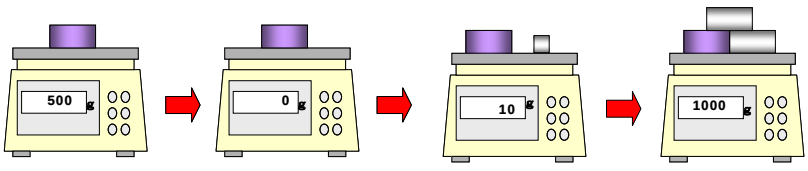
Tare weighing performance test



applied to Tare value

Tare key

Weighing test

Tare weighing performance test

TARE WEIGHING PERFOMANCE

Verification scale interval e: _____

Tare weight: ☐

E = I + 1/2 e-⊿L -L

Ec= E -Eo with E0 = error calculated at or near zero(★)

	Load (L)	Indication (I) ↑	Indication (I) ↓	Add.load (⊿L) ↑	Add.load (⊿L) ↓	Error (E) ↑	Error (E) ↓	Corrected error (Ec) ↑	Corrected error (Ec) ↓	mpe
(★)										

☐ PASSED ☐ FAILED

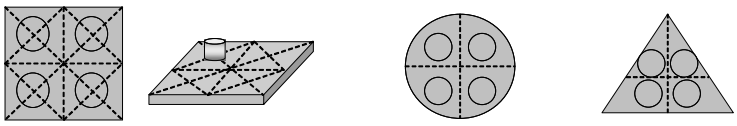
Remarks:

Eccentricity test

Instrument with a load receptor with Four or Less points of Support

Test load:

1/3 of the sum of the maximum capacity and the maximum additive tare effect



◯ Load positions

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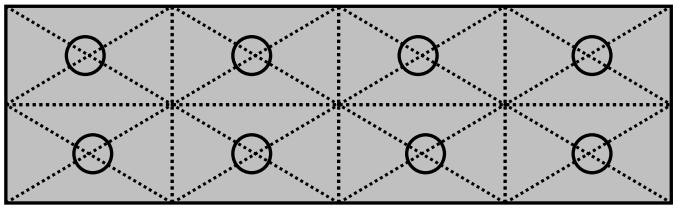
Eccentricity test

Instrument with a load receptor with more than Four points of Support

Test load:
1/(n-1) of the sum of the maximum capacity and the maximum additive tare effect



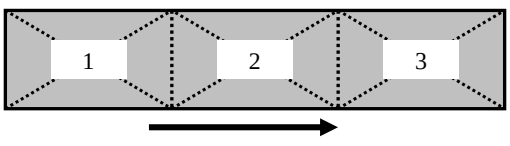
○ Load positions

AIST

Eccentricity

Instrument used for weighing Rolling loads

Test load:
Usual rolling load, the heaviest and the most concentrated one which may be weighed, but not exceeding 0.8 time of the sum of the maximum capacity and the maximum additive tare effect



driving direction

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Eccentricity Test

ECCENTRICITY

Verification scale interval e: [ ]

E = I + 1/2 e-⊿L -L

Ec= E -Eo with E0 = error calculated at or near zero(★)

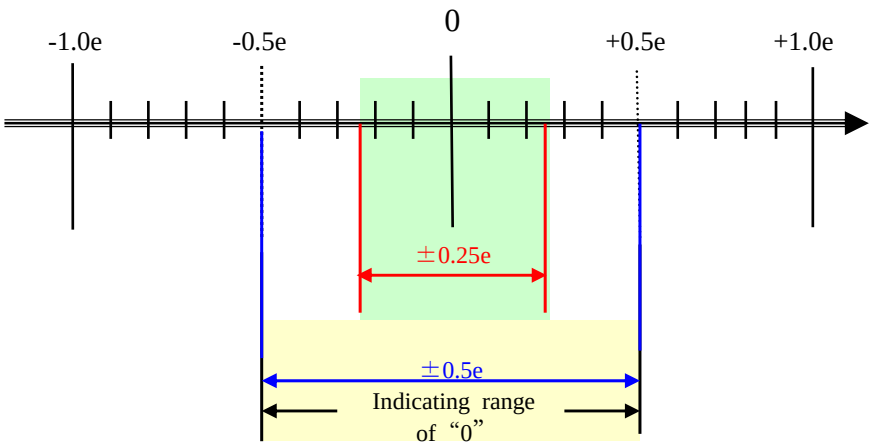
	Location	Load (L)	Indication (I)	Add.load (⊿L)	Error (E)	orrected err (Ec)	mpe
(★)							
(★)							
(★)							
(★)							
(★)							

[ ] PASSED [ ] FAILED

AIST

Zero accuracy test

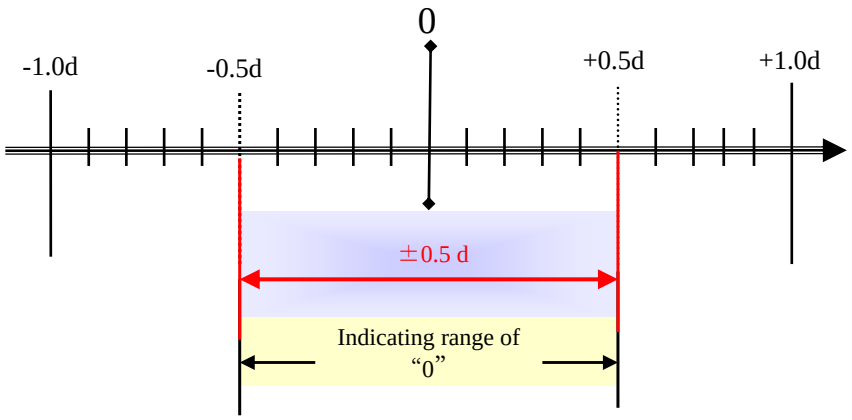
（case of “e”）



AIST

Zero accuracy test

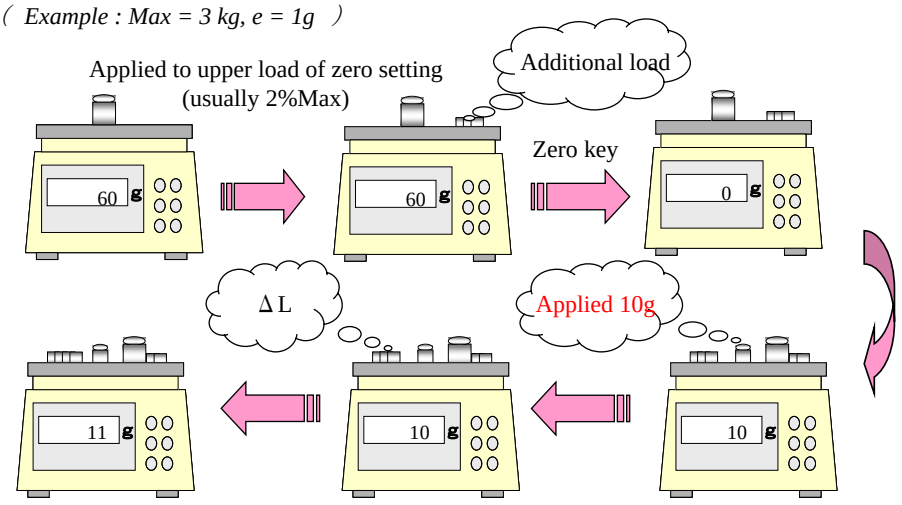
（case of “d”）



AIST

Zero setting accuracy

（ *Example : Max = 3 kg, e = 1g* ）



Change over point is applied to add load

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Zero-setting accuracy test

ZERO-SETTING ACCURACY

Verification scale interval e: _____

E = I + 1/2 e-⊿L -L

Load (L)	Indication (I)	Add.load (⊿L)	Error (E)	mpe

☐ PASSED ☐ FAILED

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Simplified procedure

To determinate Pass or Failed using the load of 1/2e and 1/4e.

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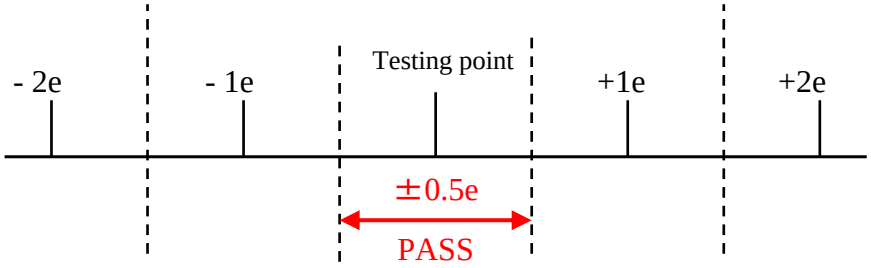
Simplified procedure

(Maximum Permissible Error : ±0.5e)



(Reference : see NMI V1 4.1)

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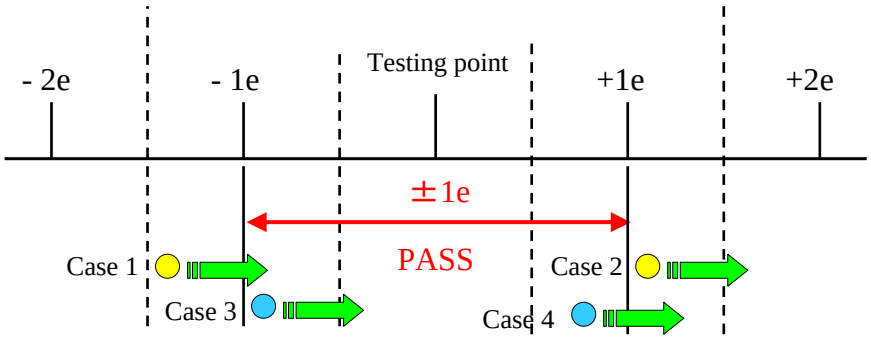
Simplified procedure

(Maximum Permissible Error : ±1e)



(Reference : see NMI V1 4.1)

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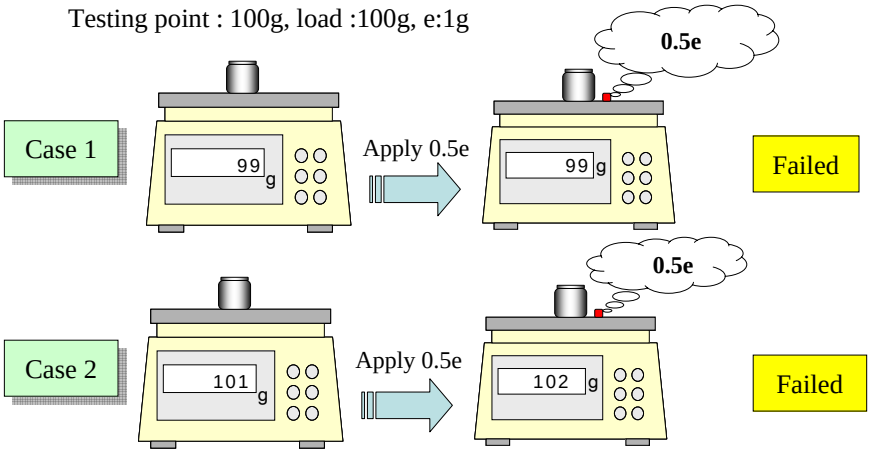
Simplified procedure

(Maximum Permissible Error : ±1e)

Testing point : 100g, load :100g, e:1g



(Reference : see NMI V1 4.1)

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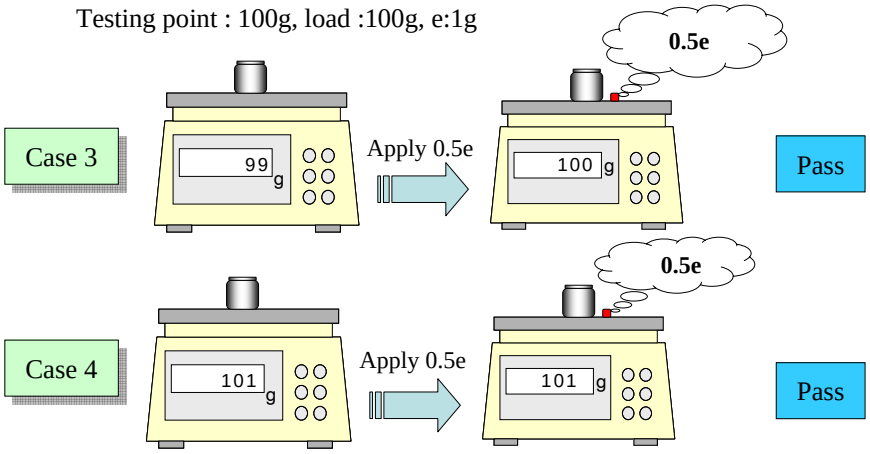
Simplified procedure

(Maximum Permissible Error : ±1e)

Testing point : 100g, load :100g, e:1g



(Reference : see NMI V1 4.1)

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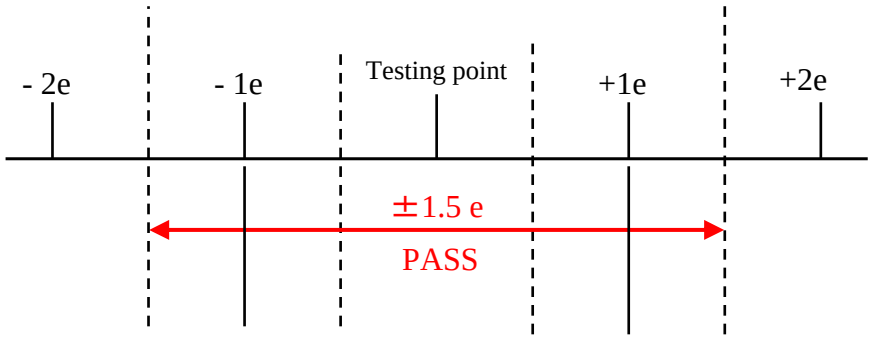
Simplified procedure

(Maximum Permissible Error : ±1.5e)



(Reference : see NMI V1 4.1)

AIST

Simplified procedure

(Maximum Permissible Error)

mpe	Indication (A)	Indication (B)	Pass or Failed
±0.5e	Same	–	Pass
	±1 e	–	Failed
±1.0e	Same	–	Pass
	+1 e	Not change	Pass
		Change of +2e(for testing point)	Failed
	- 1e	Change (for testing point)	Pass
		Not change	Failed
	±2e	–	Failed
±1.5e	±1 e	–	Pass
	±2 e	–	Failed

Note : Indication (A) :Relation between test load and indication (?)
(B) :After apply add load 1/2e (?)

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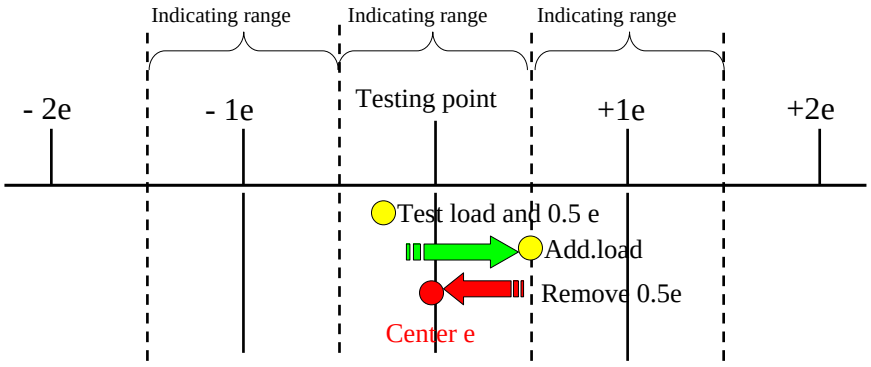
Simplified procedure
(Repeatability 1 : Center e)



Second and third indication : Apply center e load

(Reference : see NMI V1 5.1)

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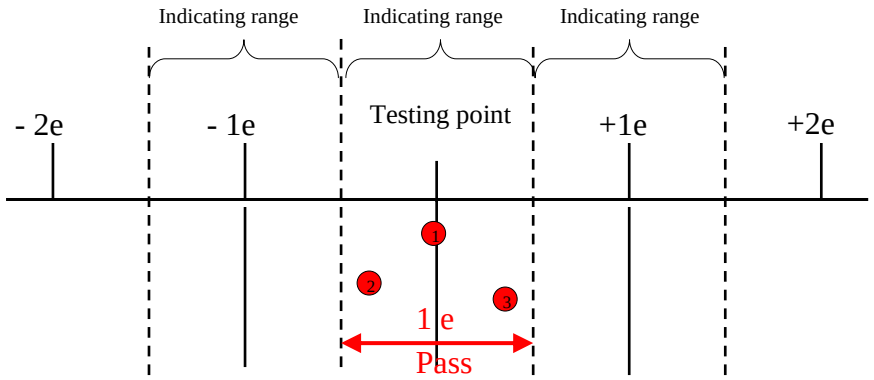
Simplified procedure
(Repeatability 2 : mpe)



All three loads show the same indication then this is pass

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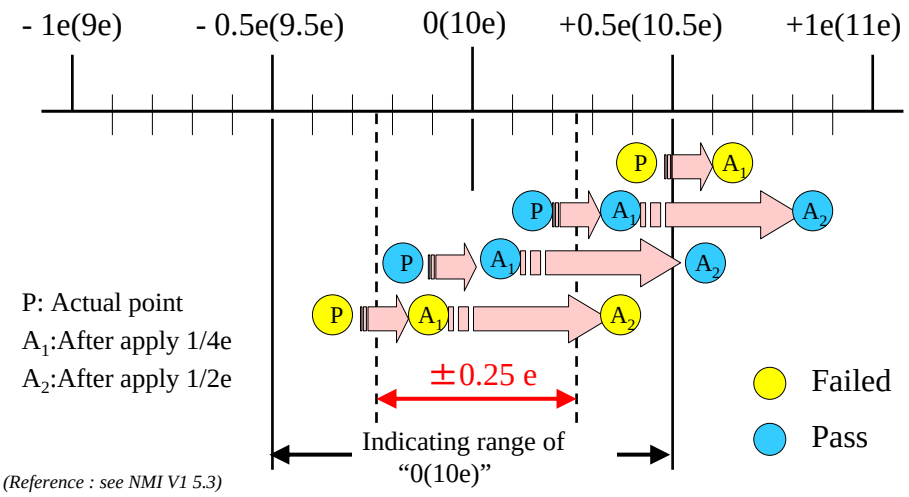
Simplified procedure

(Zero setting accuracy : case of “e”)



P: Actual point

A_1:After apply 1/4e

A_2:After apply 1/2e

(Reference : see NMI V1 5.3)

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Simplified procedure

(Zero setting accuracy : case of “e”)

Indication	applied 1/4e	applied 1/2e	Pass or Failed
0(10e)	Change	–	Failed
	Not change	Change	Pass
	Not change	Not change	Failed
±1(9,11e)	–	–	Failed

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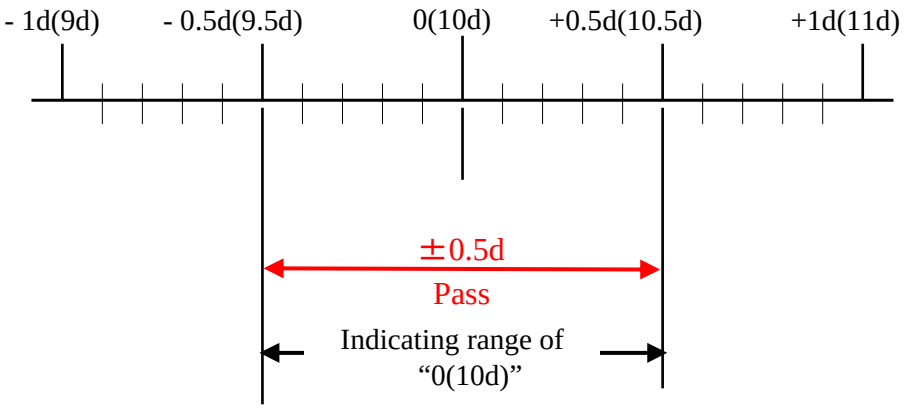
Simplified procedure

(Zero setting accuracy : case of “d”)



(Reference : see NMI V1 5.3)